The view of clouds from below and above with citizen science: The 2018 GLOBE Clouds Spring Data Challenge

J. Brant Dodson, Marilé Colón Robles, Jessica E. Taylor, Tina Rogerson, Helen Amos, Kevin Ivey, Tina Harte

28 April 2020

GLOBE Program: Citizen Science Data

The Global Learning and Observations to Benefit the Environment (GLOBE) Program is a NASA-funded international science and education program.

Provides student and the general public with opportunities to participate in data collection and the scientific process, and contribute meaningfully to our understanding of the Earth system and global environment.

GLOBE Clouds is LaRC specialty – collocated ground cloud obs. with satellite data

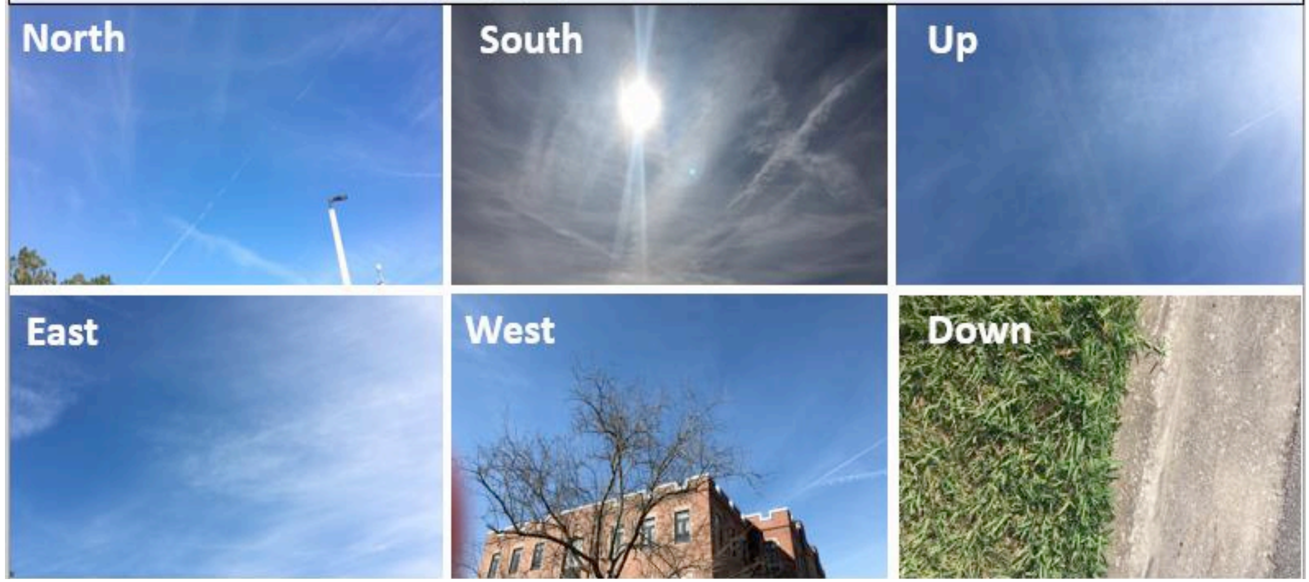
In addition to outreach, GLOBE Clouds supports the CERES mission and broader atmospheric science community by providing ground observations to complement and validate spaceborne measurements

To bolster normal data collection and public enthusiasm, GLOBE Clouds has performed two intensive observing periods, the Spring and Fall Cloud Challenges

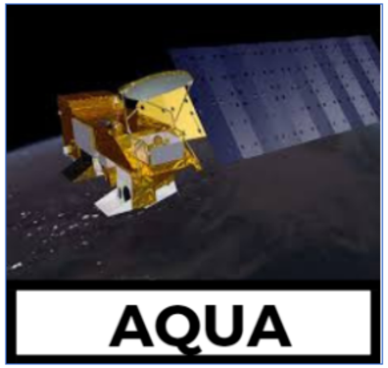
I will discuss some of the early results based on data collected during the Challenges

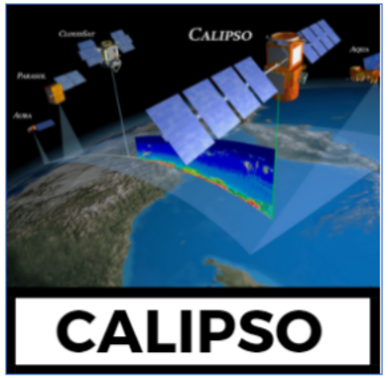
The GLOBE Observer app allowed participants to easily report weather with just their own phones

Observation	Detailed Options	Required
Total Cloud Cover	No Clouds, Few <10%, Isolated 10-25%, Scattered 25-50%, Broken 50-90%, Overcast 90-100%	Y
Obscuration (if >.25% sky covered)	Sand, Spray, Smoke, Dust, Haze, Blowing Snow, Heavy Rain, Fog, Volcanic Ash	Y
Sky Color (if <50% cloud cover)	Deep Blue, Blue, Pale Blue, Light Blue, Milky	N
Sky Visibility (if <50% cloud cover)	Unusually Clear, Clear, Somewhat Hazy, very Hazy, Extremely Hazy	N
Cloud Types by Height	High: Short-lived Contrails, Persistent Contrails, Persistent Spreading Contrails, Cirrus, Cirrostratus, Cirrocumulus Middle: Altostratus, Altocumulus Low: Fog/Stratus, Nimbostratus, Stratocumulus, Cumulus, Cumulonimbus	N
Opacity by Height	Opaque, Transparent, Translucent	N
Cloud Cover by Height	No Clouds, Few <10%, Isolated 10-25%, Scattered 25-50%, Broken 50-90%, Overcast 90-100%	N
Surface Condition	Yes/No: Snow/Ice, Standing water, Muddy, Dry Ground, Leaves on Tress, Raining/Snowing	Y
Photographs	Citizen scientists are encouraged to take observations in an outdoor area with a relatively unobstructed view of the sky. The GLOBE Observer mobile app guides users to orient their smartphone cameras horizontally, aligned in the cardinal directions, and tilted to a 14 degree angle, then automatically takes the photographs (GLOBE, 2019).	N



Satellite Matching – giving a view of clouds from above and below





NASA Cloud Observation and Satellite Match

Satellite	GEO	Aqua	Terra	Your Observation
Universal Date/Time 2019-05-02	11:10	10:57	10:52	11:00
Latitude Range Longitude Range	45.17 to 45.81 15.24 to 15.88	45.06 to 45.86 15.23 to 16.03	45.09 to 45.89 15.1 to 15.9	**Latitude 45.48** **Longitude 15.55**
Total Cloud Cover	Scattered 41.67%	Isolated 20.90%	Isolated 23.25%	**Scattered (25-50%)**
HIGH Cloud Cover Cloud Altitude Cloud Phase Cloud Opacity	No Clouds	Few (0.37%) 8.73 (km) Ice 227.01 (K) Transparent	No Clouds	
MID Cloud Cover Cloud Altitude Cloud Phase Cloud Opacity	Isolated 11.11% 2.37 (km) Water 279.13 (K) Translucent	Few (0.10%) 5.79 (km) Ice 251.55 (K) Transparent	Few (6.35%) 3.18 (km) Ice 269.56 (K) Transparent	
LOW Cloud Cover Cloud Altitude Cloud Phase Cloud Opacity	Scattered 30.56% 1.07 (km) Water 287.39 (K) Transparent	Isolated 20.43% 1.58 (km) Mixed 278.21 (K) Transparent	Isolated 16.90% 1.31 (km) Water 280.79 (K) Translucent	Cumulus Scattered (25-50%) Translucent
Corresponding NASA Satellite Images. Click to view image --->	***METEOSAT-11*** Visible Infrared GEO Tutorial	***MODIS*** Rapid Response Worldview MODIS Tutorial	***MODIS*** Rapid Response Worldview MODIS Guide	Sky Visibility : Clear Sky Color : Blue

Are there any comments you would like to add? Be sure to add the name of the satellite for our record.

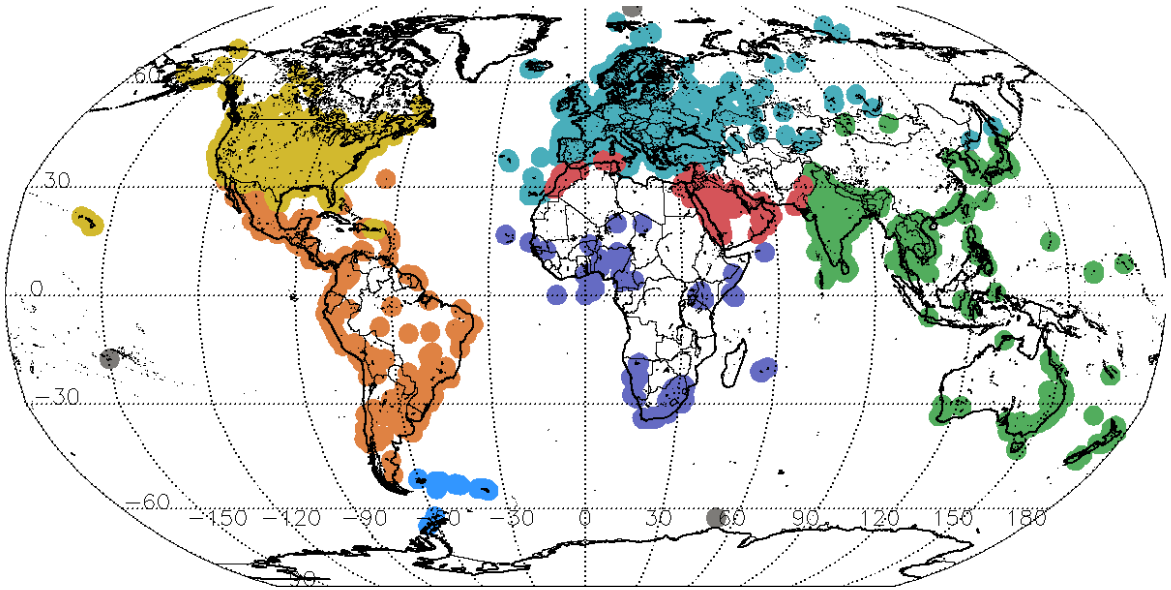
Aqua/Terra Cloud data are taken from the CERES FLASH_SSF dataset

Submit Comment

Surface Conditions

Snow/Ice	No
Standing Water	No
Muddy	No
Dry Ground	Yes
Leaves on Trees	Yes
Raining or Snowing	No

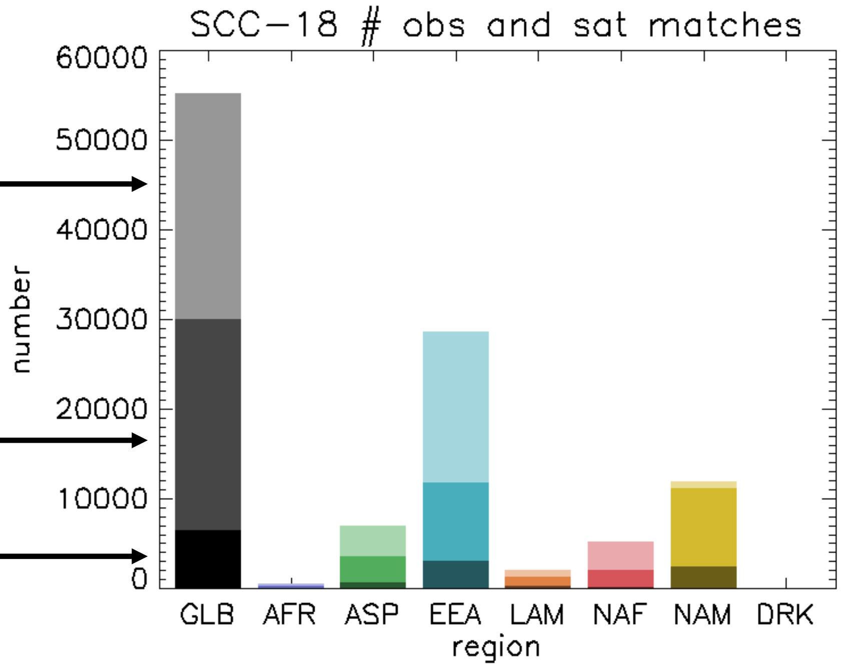
Spring Cloud Challenge (15 Mar -15 Apr 2018)



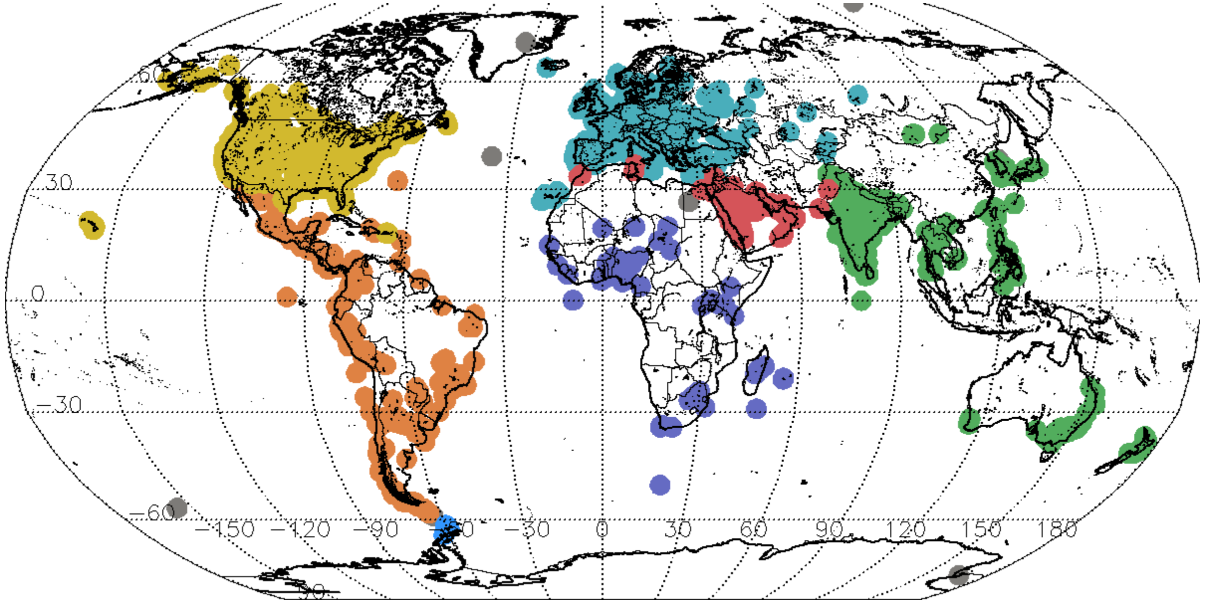
obs.

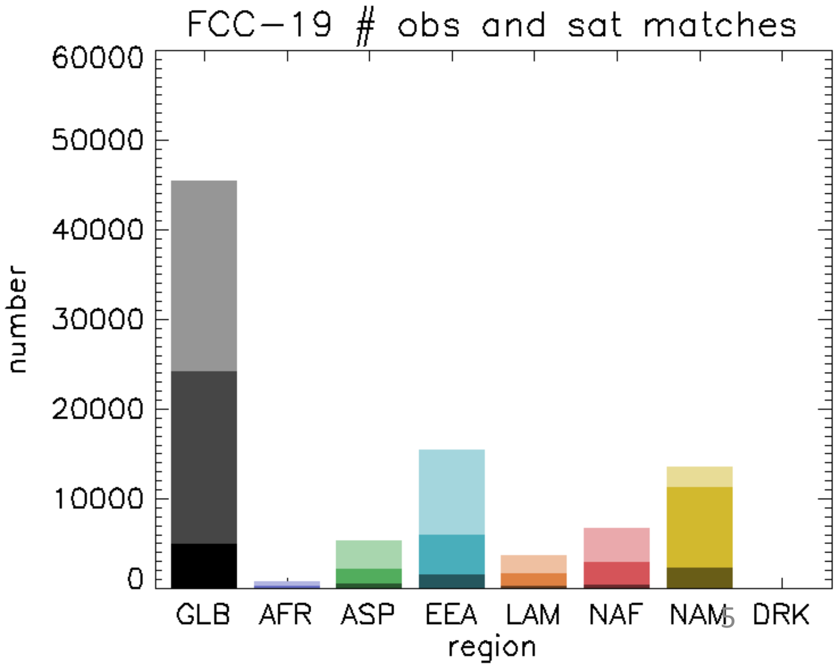
sat matches.

Terra/Aqua matches



Fall Cloud Challenge (15 Oct -15 Nov 2019)





Clouds Around the World: How a Simple Citizen Science Data Challenge Became a Worldwide Success

Marilé Colón Robles[1,2], Helen M. Amos[3,4], J. Brant Dodson[1,2], Jeffrey Bouwman[5], Tina Rogerson[1,2], Annette Bombosch[6], Lauren Farmer[6], Autumn Burdick[7], Jessica Taylor[2], *and* Lin H. Chambers[2]

[1] *Science Systems and Applications, Inc., Hampton, VA*
[2] *NASA Langley Research Center, Hampton, VA*
[3] *Science Systems and Applications, Inc., Lanham, MD*
[4] *NASA Goddard Space Flight Center, Greenbelt, MD*
[5] *Shumate Middle School, Gilbraltar, MI*
[6] *Polar Citizen Science Collective, Leicestershite, UK*
[7] *Science Systems and Applications, Inc, Pasadena, CA*

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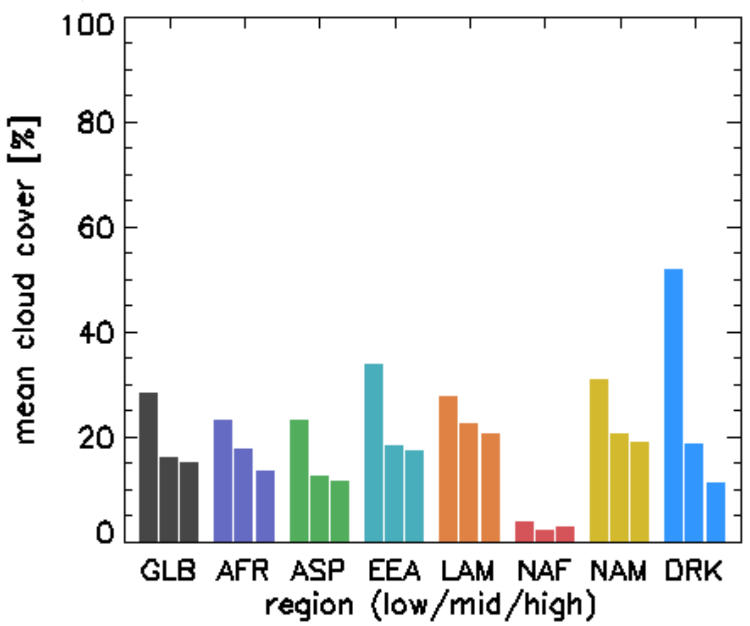
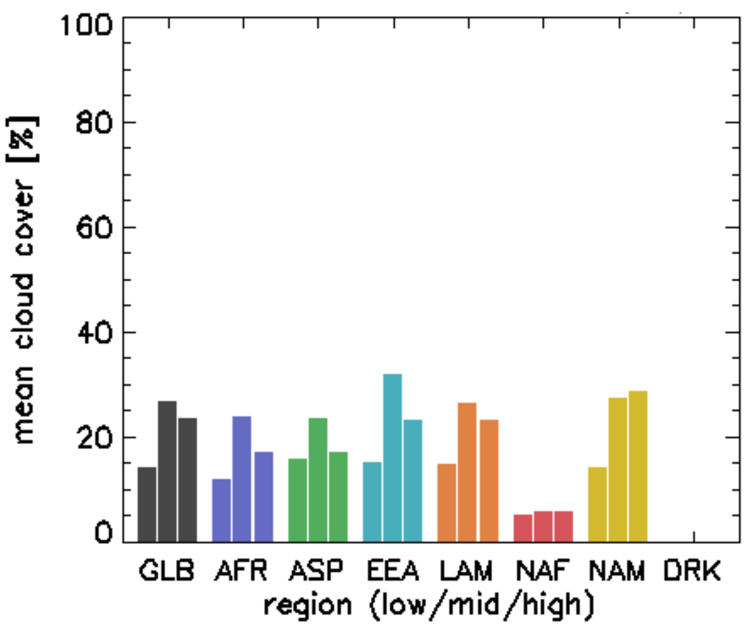
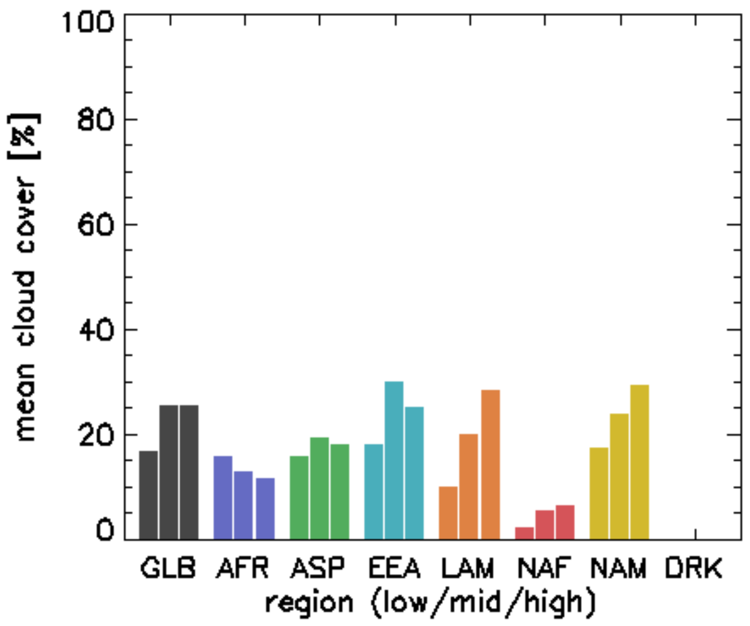
Mean Cloud Cover Seen from the Ground



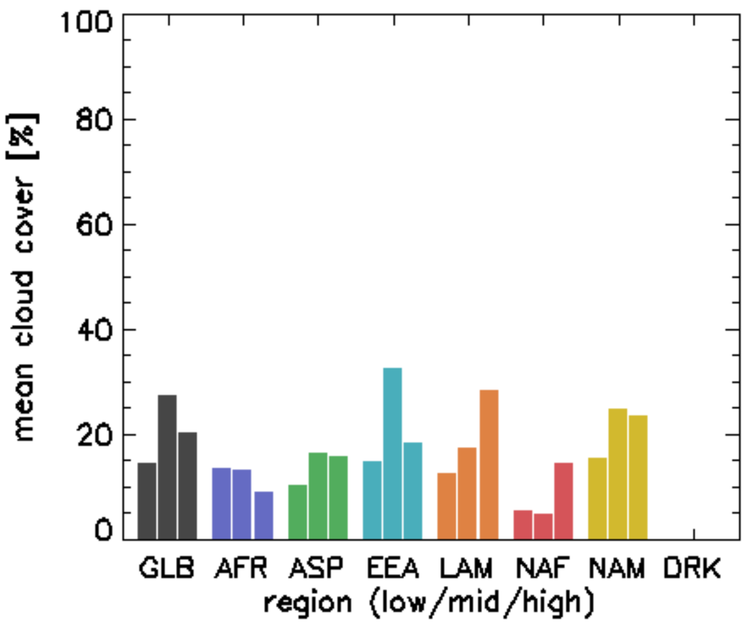
Mean Cloud Cover Seen from GEO



Mean Cloud Cover Seen from Aqua



Mean Cloud Cover Seen from Terra



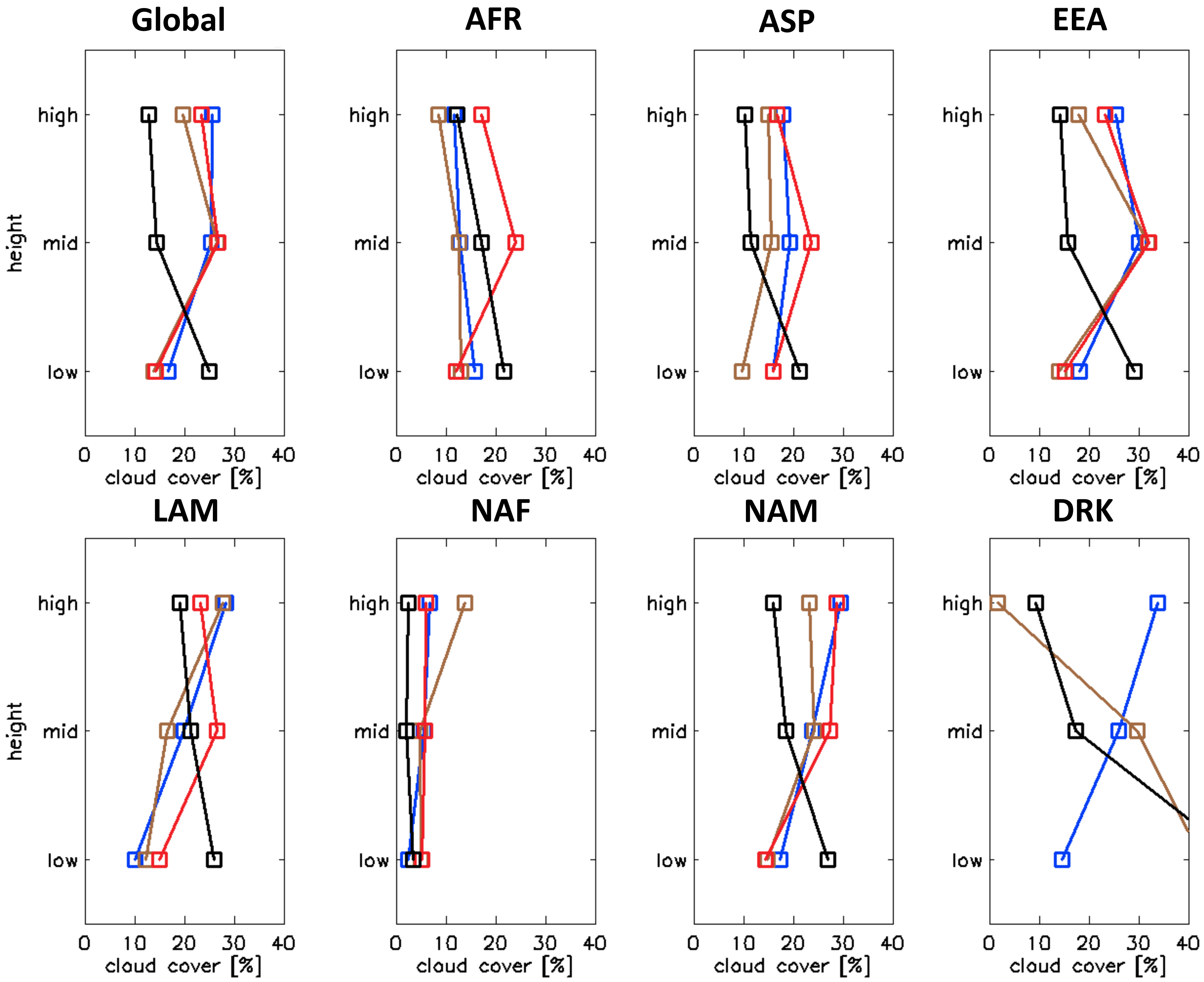
GLOBE Observer (GO) and Satellites Agree on Global Cloud Cover.

Mean cloud cover in most regions is similar, when we may expect disagreement of 5% or more.

Terra and Aqua data show similar agreement on mean global cloud cover.

There does not have to be such close agreement, as other varbs (e.g. cloud occurrence freq.) disagree by > 10%.

This result allows easier investigation of differences in cloud cover by height.



Vert. Prof. of Mean Cloud Cover

GLOBE GEO Aqua Terra

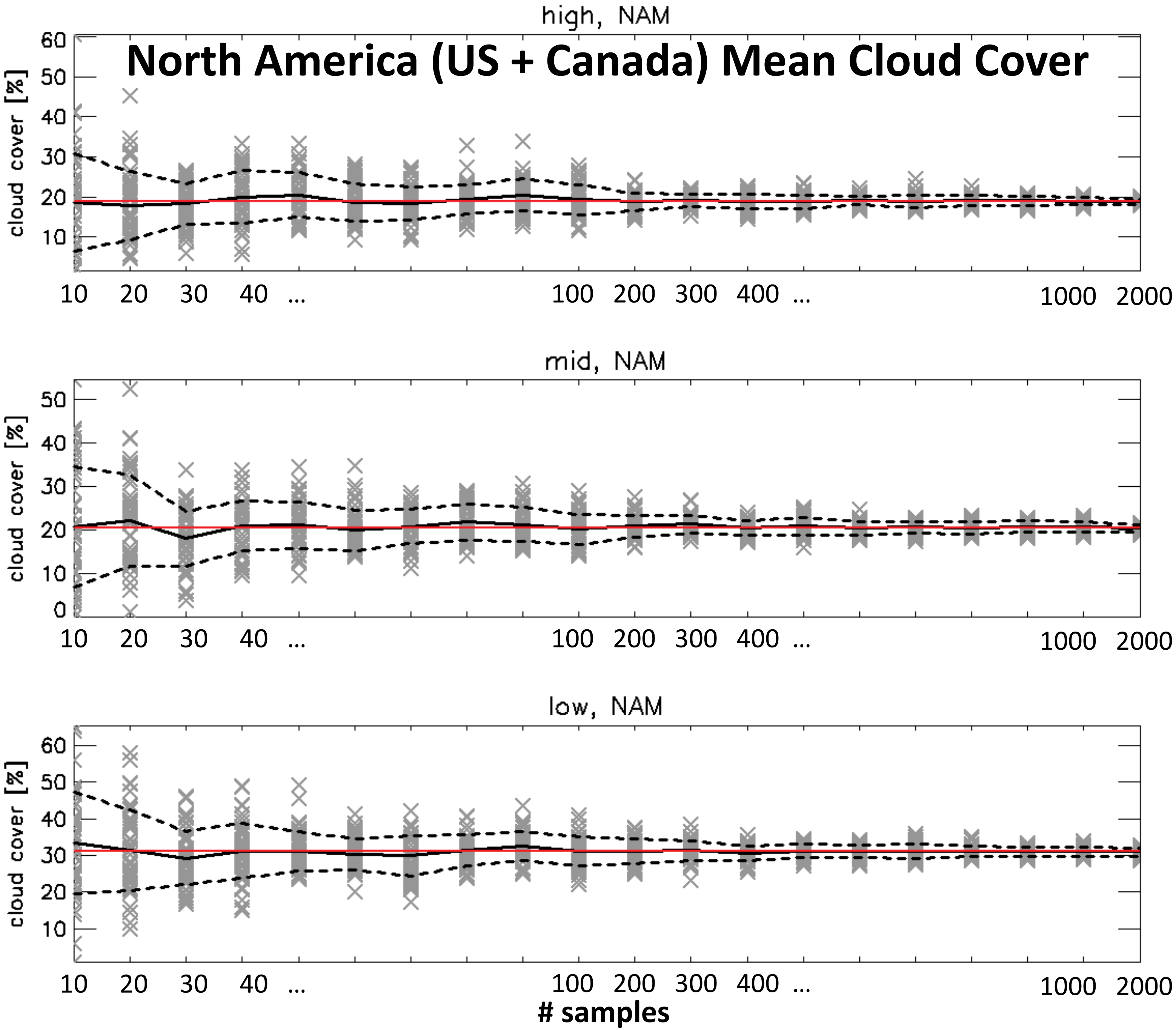
The vertical profile of cover differ between GO and satellites globally and regionally.

Some difference is expected because of different viewpoint of ground vs. space.

Global difference makes sense – ground observers will see more low clouds than high clouds; vice versa from space.

Disagreements between Terra and Aqua may arise from diurnal cycle. (WIP)

North America (US + Canada) Mean Cloud Cover



Question: What is the uncertainty of GO mean cloud cover caused by limited GO observations?

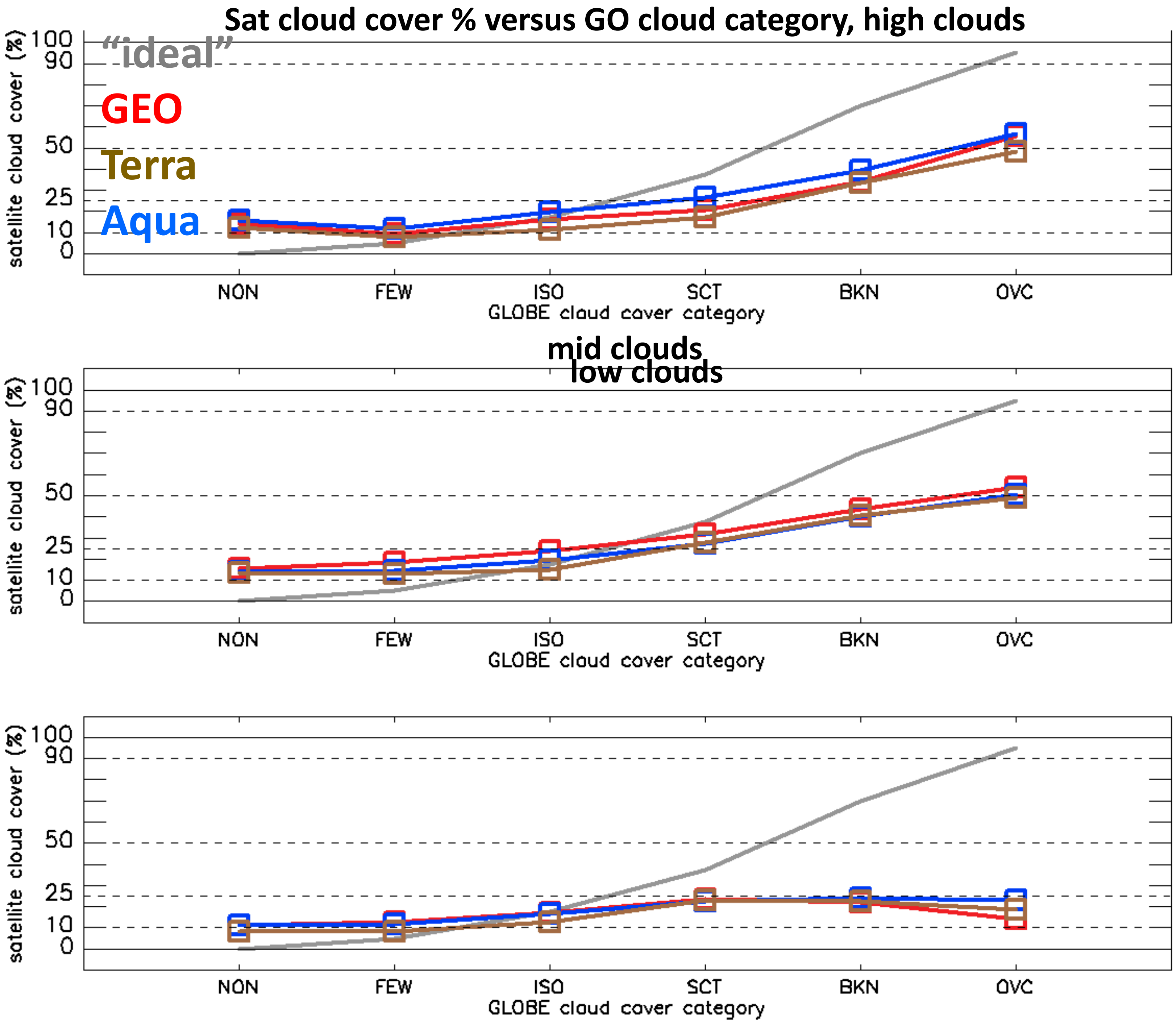
In other words, what is the value of large numbers of obs.?

NAM has ~12,000 obs, and provides an opportunity to subsample set of obs to determine sensitivity of mean cloud cover to sample size.

Method:

1. Take small number of NAM obs. (such as 10), and calculate mean cover from that subsample
2. Repeat subsampling and calculation many times (50 in this example)
3. Increment number of samples (ex. 20), and repeat (1) and (2)

Result shows how uncertainty of mean cover is reduced as sample size increases.

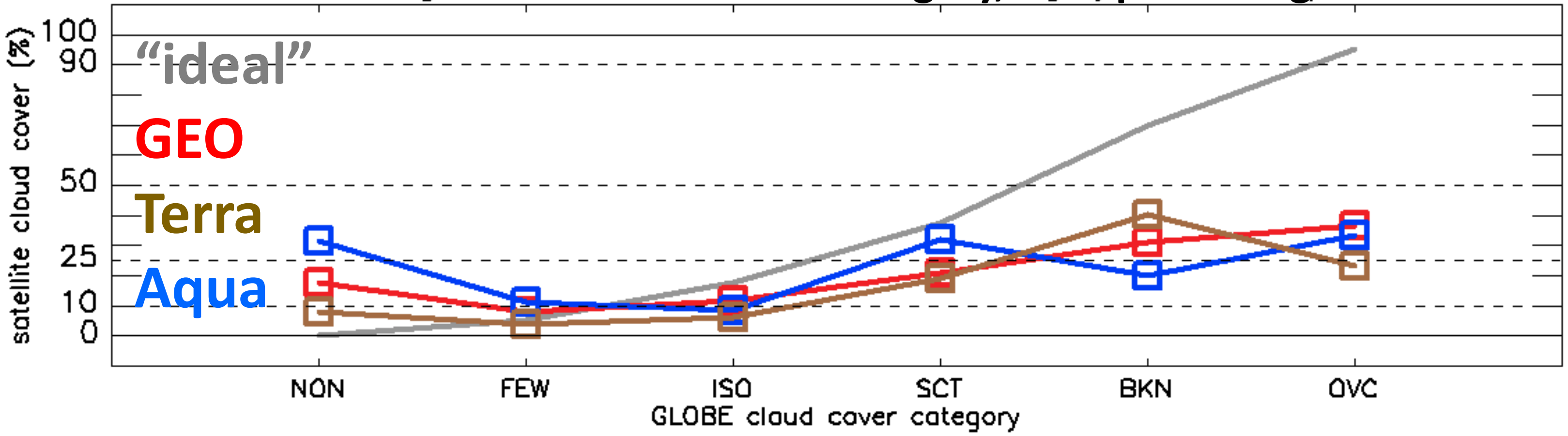


GO and sats agree closely on mean cloud cover.
However, previous studies found that ground observers tend to overestimate cloud cover.
What leads to the close agreement of our results?

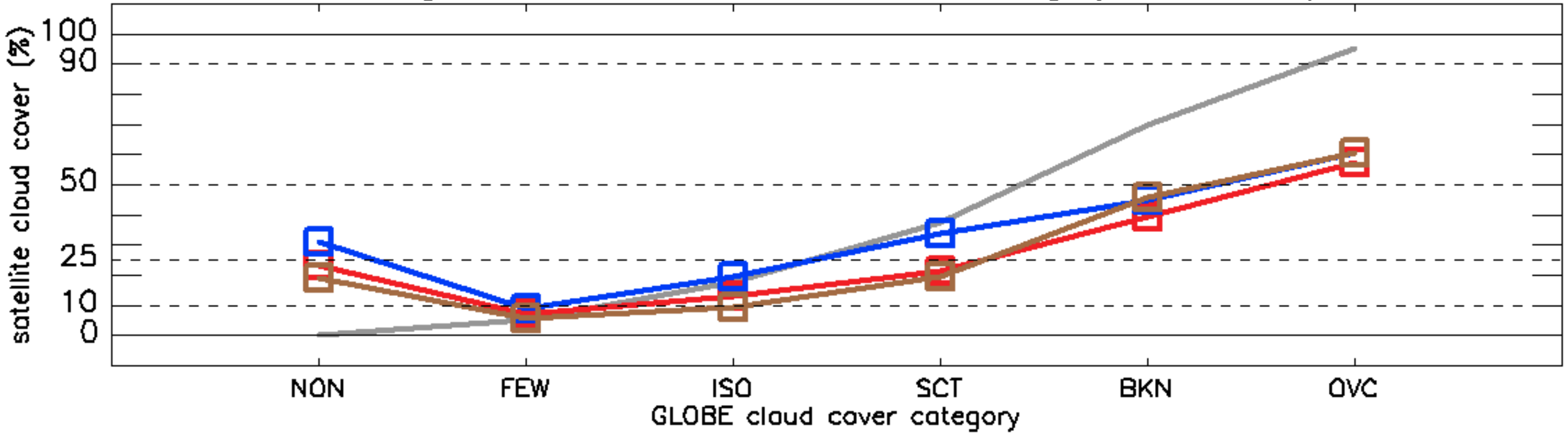
At all altitudes, sats report less cloud cover than GO in cloudy conditions (as previously found).
However, sats report greater cloud cover than GO in clear conditions.
So GO/sat agreement on mean cloud cover occurs because of compensating errors in cloudy and clear conditions.

For low clouds, "OVC" disagreement is greater because sats often cannot see low cloud cover.

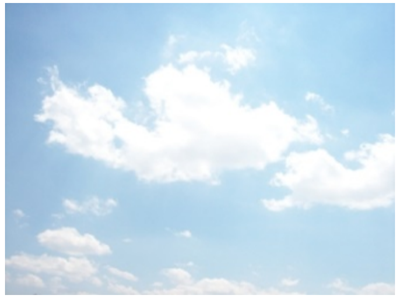
Sat cloud cover % versus GO cloud category, transparent high clouds



translucent high clouds



Transparent



Translucent

Opaque

Passive sat instruments struggle to detect/retrieve optically thin high clouds.
Previous studies use active sat measurements (i.e. CALIPSO).
Can GO data inform us about high clouds missed by sats?

Is GO/sat comparison sensitive to cloud optical depth?

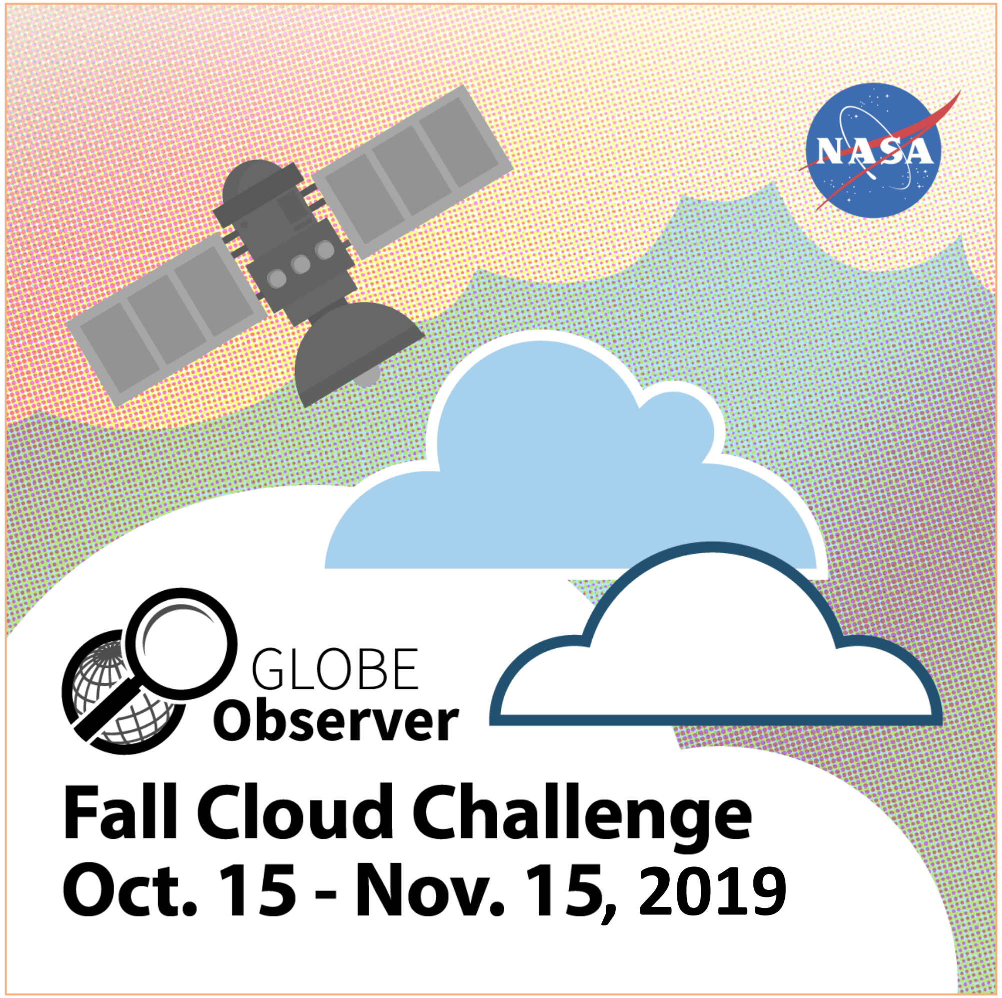
GO participants commonly report cloud opacity by altitude.

In cloudy conditions, sats have change in agreement of 15-35%.

Terra/Aqua are more strongly affected than GEO.

Opacity is the largest tested factor influencing GO/sat agreement, and results from SCC and FCC agree.

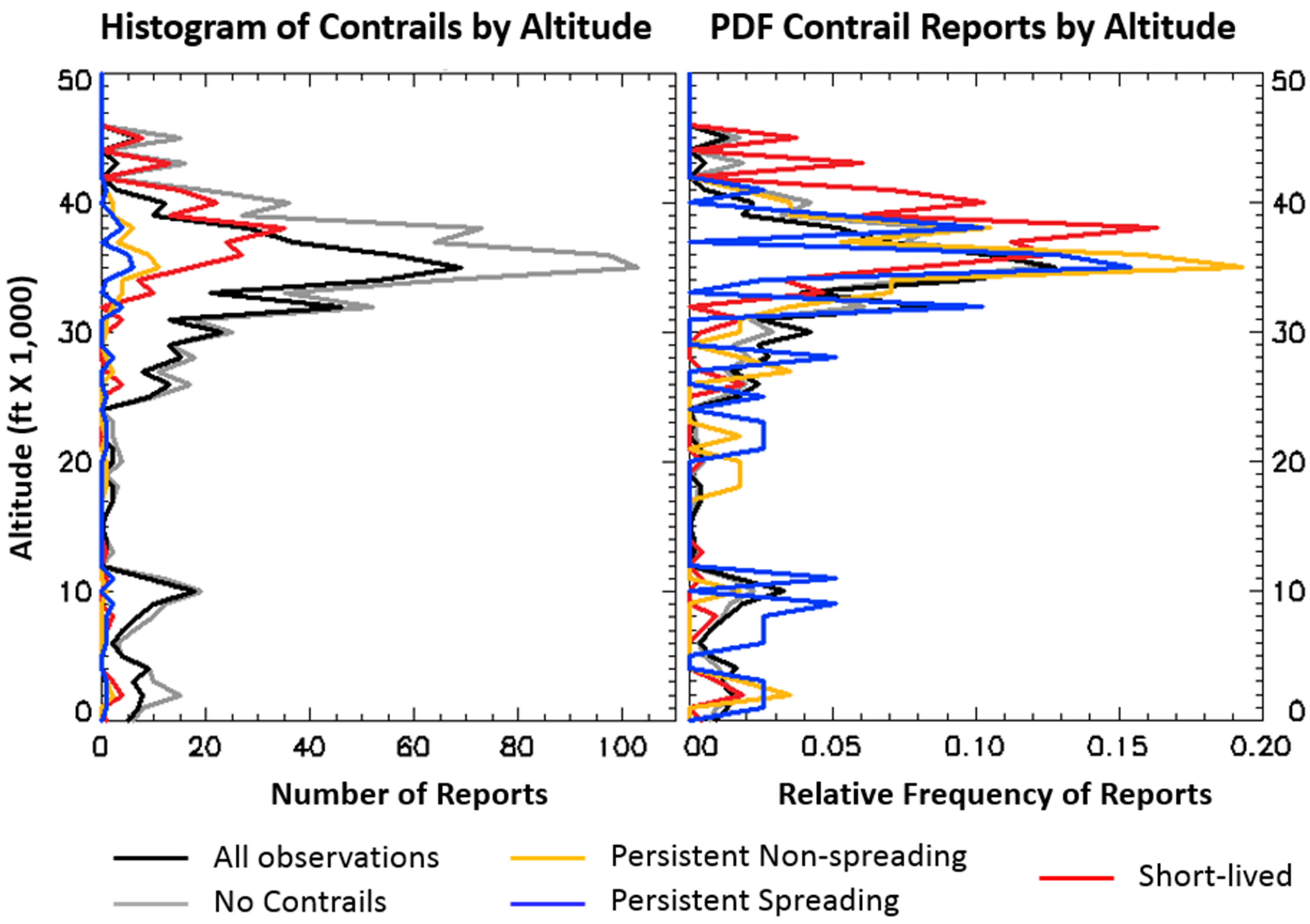
Future Cloud Challenges



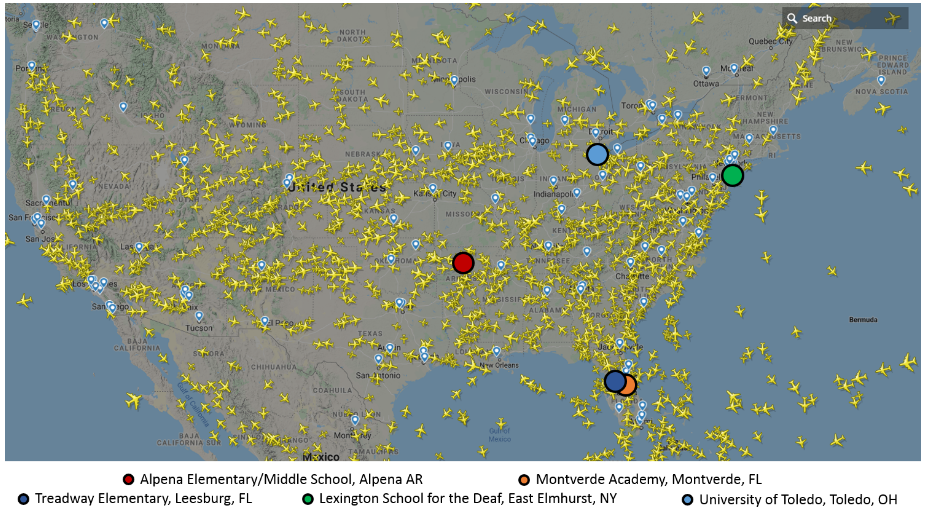
Data sets of clouds and sky conditions for each season:

- Summer Cloud Challenge 2020
- Winter Cloud Challenge 2021

Contrails Investigation Pilot



Development of an automatic input system to increase the number of participants and their entry.

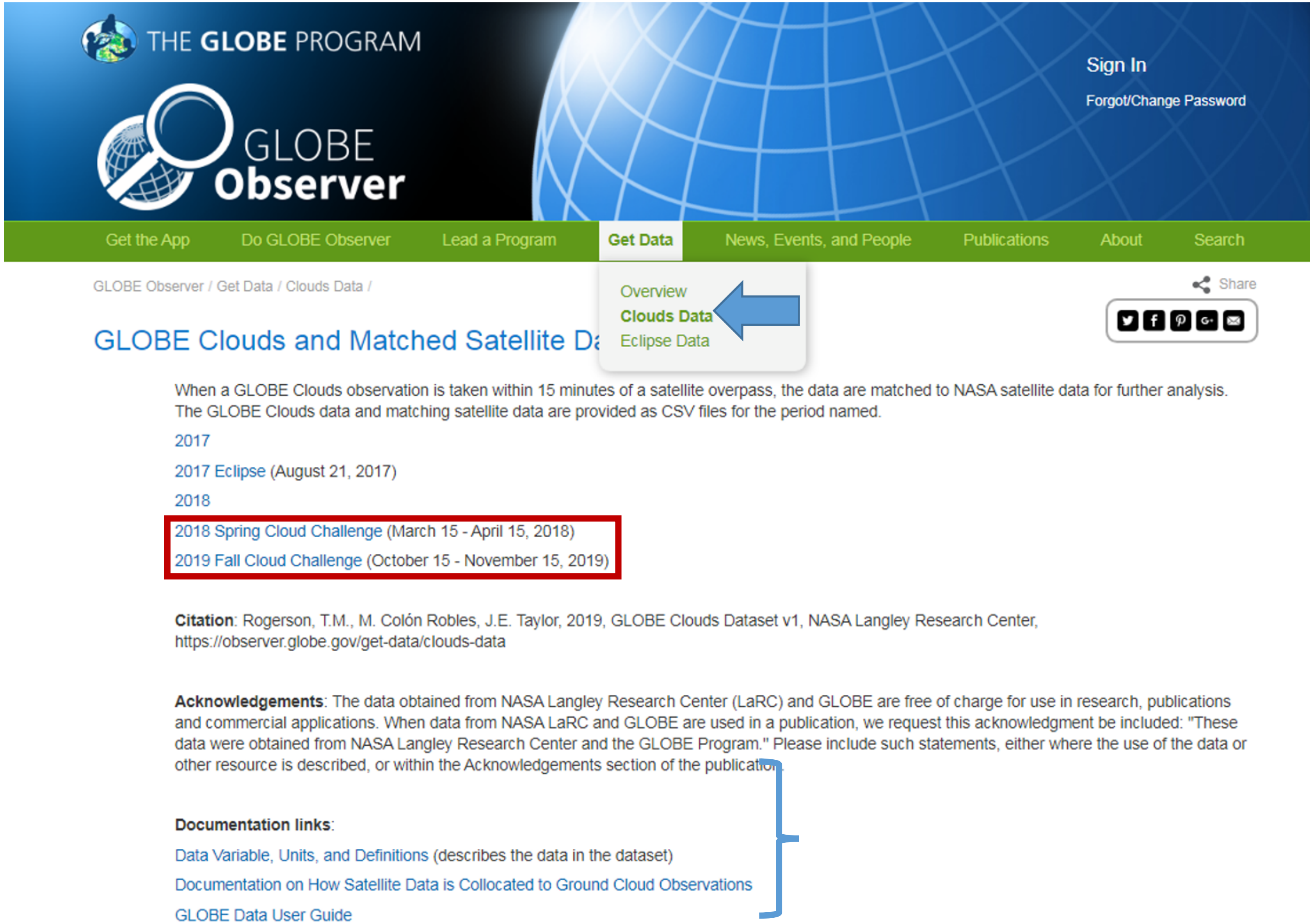


°CICERO

Center for International Climate Research

https://cicero.oslo.no/en

https://observer.globe.gov/get-data/cloud-data



If you are interested in obtaining the data, please access it at this location.

These datasets include the collocated satellite observations.

ROSES – Citizen Science A.41

A.41 CITIZEN SCIENCE FOR EARTH SYSTEMS PROGRAM

NOTICE: NASA anticipates soliciting this program element in the spring of 2020. The final text will be released as an amendment to ROSES-2020 with a submission deadline no fewer than 90 days after the release of the amendment.

The program aims to advance the use of citizen science in scientific research about the Earth by directly supporting citizen science activities, as well as by deploying technology to further citizen science research. ESD encourages proposals in particular that connect to the utilization of unique NASA capabilities in studies of the Earth.

This solicitation is expected to be released in the Spring of 2020. Funding for this opportunity is anticipated to be $2M/year. Proposers can visit https://science.nasa.gov/citizenscience for additional information on SMD citizen science activities.

Point of Contact for Further Information

Kevin Murphy
Earth Science Division
Science Mission Directorate
Telephone: (202) 358-3042 Email: kevin.j.murphy@nasa.gov

https://nspires.nasaprs.com/external/viewrepositorydocument/cmdocumentid=734922/solicitationId=%7BAE8A7AAA-4590-D9C8-FD14-2BBC4D7F152C%7D/viewSolicitationDocument=1/A.41%20CSESP.pdf

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES – 2019 (ROSES-2019)

(i) Citizen science

Citizen science is a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process. Proposers to any ROSES program element are invited to incorporate citizen science and crowdsourcing methodologies into their submissions, where such methodologies will advance the objectives of the proposed investigation. The current SMD Policy on citizen science~~, that~~ describes standards for evaluating proposed and funded SMD citizen science projects. For more information see Section 3 H.R.6414 - Crowdsourcing and Citizen Science Act of 2016, which authorizes federal agencies to utilize crowdsourcing and citizen science and the https://science.nasa.gov/citizenscientists webpage, that provides information about existing SMD-funded projects, including how to sign up for the NASA-SOLVE email listserve.

ROSES-19 SoS-8

Full ROSES 2019 Summary of Solicitation (PDF), https://tinyurl.com/y2fkrfnb

Additional funding may be available for proposals incorporating citizen science.

GLOBE Clouds Team

Jessica Taylor
Principal Investigator

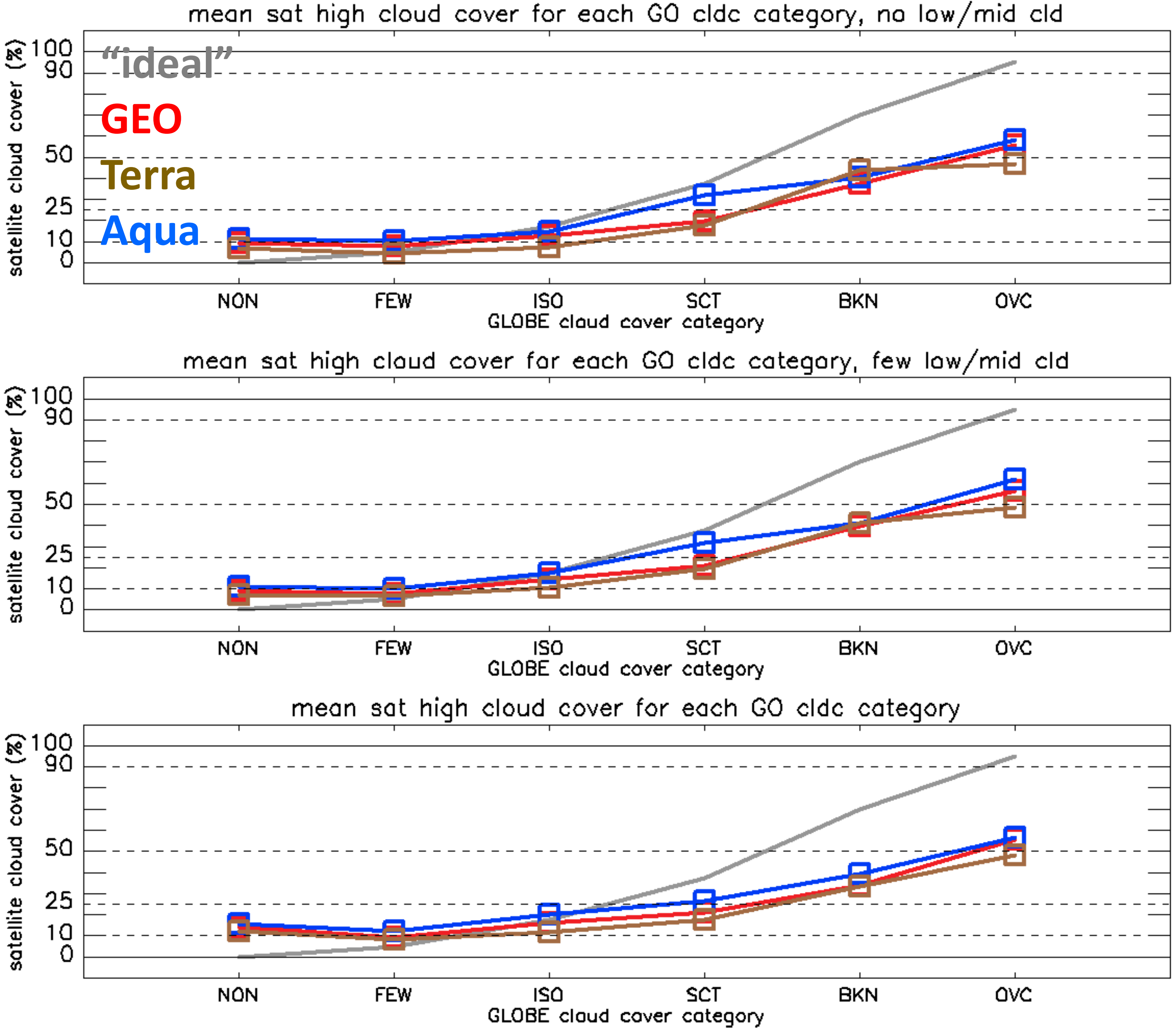
Tina Harte
Project Manager

Marilé Colón Robles
Project Scientist

Tina Rogerson
Data Manager

Research Support

Dr. Brant Dodson (left)
Mr. Kris Bedka (right)



Passive sat instruments struggle to detect/retrieve optically thin high clouds

Previous studies use active sat measurements (i.e. CALIPSO)

Can GO data inform us about high clouds missed by sats?

There may be many reasons for GO/sat disagreements

GO reporting errors

Sat retrieval errors

GO vs. sat field of view

Sat viewing angle

Etc.

But what if GO/sat comparison is contaminated by low/mid cloud cover that blocks view of GO participant from high clouds?

Restricting high cloud reports to only those with no or few low/mid clouds has little effect on GO/sat (dis)agreement